REMARKS/ARGUMENTS

1.) Claim Amendments

The Applicant has amended claims 1, 7, 12, 13, 30, 32, 34, 37, 38, 42, and 45. Claim 46 has been canceled. Accordingly, claims 1-45 are pending in the application. Favorable reconsideration of the application is respectfully requested in view of the foregoing amendments and the following remarks.

2.) Examiner Objections - Claims

The Examiner objected to claims 3, 16, 20-25, 32, and 46 as being dependent upon a rejected base claim. The Examiner stated that the claims would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. In light of the amendments and remarks below, the Applicant believes the claims are now allowable. The Examiner's allowance of claims 3, 16, 20-25, 32 and 46 is respectfully requested.

3.) Claim Rejections – 35 U.S.C. § 102(b)

The Examiner rejected claims 1 and 30 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,965,858 to Naito et al. (Naito). The Applicant has amended the claims to better distinguish the claimed invention from Naito. The Examiner's consideration of the amended claims is respectfully requested.

The Applicant has amended claims 1 and 30 to overcome the § 102(b) rejections. Claims 1 and 30 now recite that the state of polarization of the optical signal relative to the local oscillator light in the first output is not orthogonal to the state of polarization of the optical signal relative to the local oscillator light in the second output.

Naito discloses a polarized wave diversity optical receiver for coherent optical communication. Naito discloses the use of polarization diversity with optical coherent detection, while the Applicant's claimed invention is related to phase diversity. There is clear and distinct differences between polarization diversity and phase diversity.

The Examiner states in the Office Action that the element of claims 1 and 30 "wherein the phase relationship between the optical signal and the local oscillator light

in the first output is different from 0 degrees and different from 180 degrees compared to the phase relationship between the local oscillator light and the optical signal in the second output" is disclosed in Naito (figure 19; column 19 lines 36-42). The Applicant respectfully disagrees with this characterization. The cited passages of Naito in fact describe how the phase of the intermediate frequency electrical signal is controlled by phase modulating unit 14 after photodetection, so that the phase difference between the two electrical signals (after photodetection) can be changed from 0 to 180 degrees. The constraint on the phase relationship of the present patent application applies to the two optical outputs of the optical splitter/combiner network before photodetection. There is no disclosure anywhere in Naito to constrain the phase relationship between the two outputs of the optical splitter/combiner network, and thus it is not true that the phase relationship between these two optical outputs is different from 0° or 180°.

Furthermore, Naito refers to the phase relationship between the two optical outputs of the splitter/combiner network during the discussion of the issues regarding automatic frequency control pertaining to figure 2. Equations 1 and 2 of column 4 of Naito give the two electrical signals e_s and e_p output from the two photodetectors 9 of figure 2. The phase of the intermediate frequency differs between e_s and e_p by θ. Naito discloses that θ is due to polarization (column 4 lines 42-43). Although θ is the phase difference between the electrical signals after photodetection, it is caused by the phase difference between the optical signals before photodetection. In column 4, line 49 and column 5, line 7 of Naito, it states that the worst case for automatic frequency control is when $\theta = \pi$. Thus, it is explicitly stated by Naito that the phase difference between the optical outputs of the splitter/combiner network may be 180°.

Thus, there are clear and distinct differences between Naito and the Applicant's claimed invention. Therefore, the allowance of claims 1 and 30 is respectfully requested.

4.) Claim Rejections – 35 U.S.C. § 102(e)

The Examiner rejected claims 13, 19, 38, and 41 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application Publication No. 2003/0063285 to Pering et al. (Pering). The Applicant has amended the claims to better distinguish the claimed

invention from Pering. The Examiner's consideration of the amended claims is respectfully requested.

The Applicant has amended claims 13 and 38 to overcome the §102(e) rejections. Claims 13 and 38 now recite that the signal contains information and the receiver obtains that information. Pering discloses the use of heterodyne coherent detection (one output from the mixing hybrid) and applies a signal processing operation to calculate quantities which characterize the optical signal, e.g. amplitude and frequency. Pering does not disclose that the signal contains information or that the receiver obtains this information. Thus, Pering does not disclose all the elements recited in claims 13 and 38. Claim 19 depends from claim 13 and recites further limitations in combination with the novel elements of claim 13. Claim 41 depends from claim 38 and recites further limitations in combination with the novel elements of claim 38. Therefore, the allowance of claims 13, 19, 38 and 41 is respectfully requested.

5.) Claim Rejections – 35 U.S.C. § 103(a)

The Examiner rejected claims 26 and 42 under 35 U.S.C. § 103(a) as being unpatentable over Pering in view of U.S. Patent No. 6,607,311 to Fishman (Fishman). In response, the Applicant respectfully disagrees.

Claims 26 and 42 of the present invention recite subtraction of crosstalk imposed on one WDM channel by a second WDM channel, wherein the subtraction takes place within the digital signal processor in the coherent receiver. The Examiner states that Fishman teaches subtraction of crosstalk imposed on one WDM channel by a second channel, albeit using direct detection. The Applicant respectfully disagrees with this characterization. Fishman does not cover subtraction of crosstalk, but rather improves the tolerance to a given level of optical crosstalk. Fishman achieves this increase in tolerance to crosstalk by utilizing a special optical transmitter. In the Applicant's invention, the word "subtraction" refers to a mathematical subtraction process of one signal from another (see paragraphs 0159-0167). The term "subtraction" has a precise meaning which does not include the concept of "increasing tolerance to."

Fishman states that in a conventional WDM transmission system, a WDM channel is formed by modulating a single-line optical source (typically a c.w. laser).

Some network components cause in-band crosstalk, where some optical power leaks onto one channel from another channel at the same optical frequency. When both the WDM channels are modulated single-line optical sources, the inband crosstalk is coherent crosstalk, and it results in a large penalty after photodetection (see Fishman's equation 3). Fishman operates in the following fashion. A WDM channel is formed by modulating a multi-line optical source instead of a single-line optical source. The multi-line source has several optical lines that have random phase with respect to one another. The lines are separated by a spacing sufficiently large that they do not interfere with one another, but all the lines fit within a standard WDM channel slot. When a multi-line source WDM channel experiences the same level of in-band crosstalk from another multi-line source, the corresponding penalty after photodetection is lower (see Fishman's equation 4), because the crosstalk is incoherent crosstalk instead of coherent crosstalk. The Examiner cites column 7 lines 35-38, but this passage does not appear to be relevant. The Examiner may have intended to refer to the next sentence, "When a MLS 30 is used in combination with this switch fabric, the output system cross-talk is reduced." The output system cross-talk referred to here is the impact of the optical crosstalk after photodetection. There is a reduction in this output system cross-talk for the same level of optical crosstalk because of the increased tolerance to optical crosstalk imparted by the use of the multi-line source. No subtraction operation is involved.

Fishman's invention utilizes a non-standard optical transmitter, whereas the crosstalk subtraction in the Applicant's claimed invention is performed in the receiver. The only discussion of the receiver by Fishman is in column 6 lines 26-27: "Receivers 70 detect and process the signal." The network architectures contemplated by Fishman that cause crosstalk imposed on one WDM channel by another WDM channel are those using optical add/drop multiplexers (Fishman's figure 3) or optical cross-connect switches (Fishman's figure 4). When optical ADMs or optical cross-connect switches cause in-band optical crosstalk, the channel imposing the crosstalk is delivered to a different destination to the channel experiencing the crosstalk. So the channel imposing the crosstalk is not available in the locality of the channel experiencing crosstalk to take

part in a crosstalk subtraction operation. Thus, Fishman clearly does not teach or suggest crosstalk subtraction as defined by the Applicant.

Claims 27, 28, and 29 depend from claim 26 and recite further limitations in combination with the novel elements of claim 26. Claims 43 and 44 depend from claim 42 and recites further limitations in combination with the novel elements of claim 42. Therefore, the allowance of claims 26, 27, 28, 29, 42, 43, and 44 is respectfully requested.

The Examiner rejected claims 14, 15, 18, 19, 21, 39, 40, and 41 under 35 U.S.C. §103(a) as being unpatentable over Pering in view of U.S. Patent Application Publication No. 2002/0012152 to Agazzi et al. (Agazzi). The Applicant has amended the claims to better distinguish the claimed invention from Pering and Agazzi. The Examiner's consideration of the amended claims is respectfully requested.

The Applicant has amended independent claims 13 and 38. Claims 13 and 38 now recite that the signal contains information and the receiver obtains that information. Pering discloses the use of heterodyne coherent detection (one output from the mixing hybrid) and applies a signal processing operation to calculate quantities which characterize the optical signal, e.g. amplitude and frequency. Pering does not disclose that the signal contains information or that the receiver obtains this information. Agazzi does not make up the missing elements.

The Applicant's claimed invention recites a digital signal processor in the receiver which performs several possible signal processing options. Claims 14 and 39 cover compensating (at least partially) for a fiber propagation impairment. Claim 15 covers compensation for chromatic dispersion. Claims 18 and 40 cover compensation for multipath interference. Claim 21 covers feedforward equalization-decision feedback equalization. The Examiner stated that while Pering does not include these signal processing options, Agazzi does include them. Furthermore, the Examiner stated that it is obvious to one who is skilled in the art to combine the two inventions.

Agazzi discloses direct detection of optical signals followed by A/D conversion and digital signal processing. Agazzi provides examples of fiber optic propagation impairments, including chromatic dispersion and polarization mode dispersion (PMD), which can be compensated for by the digital signal processor. The algorithms used to

perform equalization are maximum likelihood sequence estimation (MLSE, also known as Viterbi equalization), feedforward equalization (FFE) and decision feedback equalization (DFE).

The Applicant respectfully disagrees that the combining Agazzi for impairment equalization following direct detection with Pering for an optical spectrum analyzer using coherent detection makes the present invention obvious.

Pering discloses that the local oscillator is a swept local oscillator. It is necessary to sweep the local oscillator wavelength in order to obtain an optical spectrum, which is the purpose of Pering's invention. Agazzi's invention is used on optical communications signals, which are customarily fixed in wavelength. To apply coherent optical detection to Agazzi's invention in place of direct detection, it would be necessary to use a local oscillator which is fixed in wavelength. However it is not a minor change to have Pering's local oscillator fixed instead of swept in wavelength, as this change stops Pering's coherent receiver from functioning as an optical spectrum analyzer. The combination of Pering's coherent receiver with Agazzi's optical receiver with equalization reference is an inoperative combination. Thus the combination of these two prior art references is improper.

In regards to claims 18 and 40, these claims cover compensation of multipath interference. The Examiner stated that Agazzi refers to compensation of multipath interference in paragraph 0008. However, a review of Agazzi, including paragraph 0008 provides no teaching or suggestion of multipath interference.

Claims 15, 18, 19, and 21 depends from claim 13 and recite further limitations in combination with the novel elements of claim 13. Claims 39, 40 and 41 depend from claim 38 and recites further limitations in combination with the novel elements of claim 38. Therefore, the allowance of claims 14, 15, 18, 19, 39, 40 and 41 is respectfully requested.

The Examiner rejected claims 2, 4, 5, and 31 under 35 U.S.C. § 103(a) as being unpatentable by Naito in view of Agazzi. The Applicants have amended the claims to better distinguish the claimed invention from Naito and Agazzi. The Examiner's consideration of the amended claims is respectfully requested.

The Applicant has amended independent claims 1 and 30. Claims 1 and 30 now recite that the state of polarization of the optical signal relative to the local oscillator light in the first output is not orthogonal to the state of polarization of the optical signal relative to the local oscillator light in the second output.

As discussed above, Naito discloses the use of polarization diversity with optical coherent detection, while the Applicant's claimed invention is related to phase diversity. There is clear and distinct differences between polarization diversity and phase diversity.

Additionally, Naito refers to the phase relationship between the two optical outputs of the splitter/combiner network during the discussion of the issues regarding automatic frequency control pertaining to figure 2. Equations 1 and 2 of column 4 of Naito give the two electrical signals e_s and e_p output from the two photodetectors 9 of figure 2. The phase of the intermediate frequency differs between e_s and e_p by θ. Naito discloses that θ is due to polarization (column 4 lines 42-43). Although θ is the phase difference between the electrical signals after photodetection, it is caused by the phase difference between the optical signals before photodetection. In column 4, line 49 and column 5, line 7 of Naito, it states that the worst case for automatic frequency control is when $\theta = \pi$. Thus it is explicitly stated by Naito that the phase difference between the optical outputs of the splitter/combiner network may be 180°.

The addition of Agazzi does not make up the missing elements. Furthermore, an element of claims 2 and 31 is missing from both Naito and Agazzi, i.e., the calculation of a component of the complex electric field envelope. Agazzi does not perform a computation on digital values from the A/D converters to obtain a component of the electric field envelope. The digital values from the A/D converters in Agazzi's direct detection configuration themselves represent the power of the optical signal, and no computation is necessary. On the other hand, the computation to obtain the complex electric field envelope in the present invention is not a trivial computation, as is explained in paragraphs 0052-0055 and equations 6 and 7. The requirement for a computation to be made is stated in claims 2 and 31, and the nature of the computation described in the specification, but this computation is missing from the two prior art references.

Claims 2, 4, and 5 depend from claim 1 and recite further limitations in combination with the novel elements of claim 1. Claim 31 depends from claim 30 and recites further limitations in combination with the novel elements of claim 30. Therefore, the allowance of claims 2, 4, 5, 12, 31, and 45 is respectfully requested.

In regards to claim 12, claim 12 has been amended and now recites a third output having a third replica of the optical signal and a first replica of light from the second local oscillator of the two local oscillators and the state of polarization of the light from the second local oscillator with respect to the optical signal in the third output is close to orthogonal compared to the state of polarization of light from the first local oscillator with respect to the optical signal in the first output. Additionally, claim 12 now recites a fourth output of the four outputs having a fourth replica of the optical signal and a second replica of light from the second local oscillator of the two local oscillators, wherein the phase relationship between the optical signal and the local oscillator light in the third output is different from 0 degrees and different from 180 degrees compared to the phase relationship between the local oscillator light and the optical signal in the fourth output.

Claim 12 claims a polarization diverse optical coherent detection configuration using DSP to obtain the information contained on the optical signal, where two separate local oscillator lasers are used for the two polarization paths (see paragraphs 0093-0094 of the Applicant's specification). Naito does not teach or suggest the added elements of the Applicant's claimed invention.

The Examiner points out features which claim 12 has in common with Naito and features which are not present in Naito. The features missing from Naito are the two local oscillator lasers, the optical mixing hybrid that generates four replicas of the incoming optical signal and two replicas of each of the local oscillators in four outputs. The Examiner stated that the optical mixing hybrid of claim 12 is similar to a component of Naito, but that the number of output ports is different. The Examiner further stated that number of output ports is a design choice and would be obvious to one of ordinary skill in the art. However, the Applicant respectfully disagrees with this characterization. In particular, the Examiner does not mention the absence of two local oscillators from

Naito. No prior art reference is offered which has two local oscillators. Therefore, the allowance of claim 12 is respectfully requested.

In regards to claim 45, claim 45 has been rewritten to incorporate the limitations of claim 46. The Examiner stated that claim 46 would be allowable if rewritten in independent form and incorporate the limitations of the independent claim and any intervening claims. Claim 46 has been canceled. Therefore, the allowance of claim 45 is respectfully requested.

CONCLUSION

In view of the foregoing remarks, the Applicants believe all of the claims currently pending in the Application to be in a condition for allowance. The Applicants, therefore, respectfully request that the Examiner withdraw all rejections and issue a Notice of Allowance for claims 1-46.

The Applicants request a telephonic interview if the Examiner has any questions or requires any additional information that would further or expedite the prosecution of the Application.

Respectfully submitted,

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Date: 4-16-07

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